# Deep Far-Infrared Surveys with Spitzer and 70um Confusion Limits of Future Large Telescopes

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## Summary

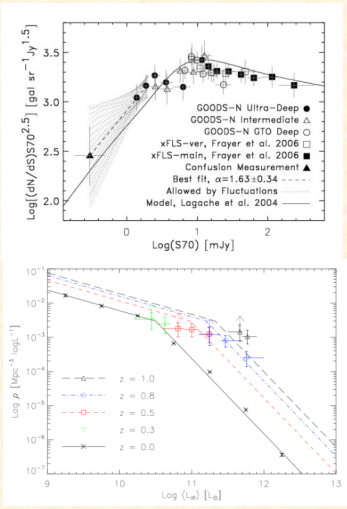
We present deep MIPS 70um and 160um legacy observations carried out with Spitzer. The COSMOS and FIDEL Cycle-3 legacy surveys will expand on the the ultra-deep 70um observations of GOODS-N (Frayer et al. 2006). The measured confusion levels are sigma=0.3mJy and ~10mJy for the Spitzer 70 and 160um bands, respectively. Based on the extrapolation of the counts, the 70um confusion levels are predicted for future large infrared telescopes, such as Herschel, SPICA, and CALISTO-5m/10m.

## Data Processing

(1) Updated BCD processing techniques with the GeRT
- ❑Optimized RADHIT removal and slope calculation
- ❑2nd-pass stim clean-up and stim calibration
- ❑Bright source masking and optimized 2nd-pass filtering
- ❑Long-term drifts removed with a high-pass time filter
- ❑ Short-term transients due to the stim latents are removed with a column filter at 70um and removed at 160um using corrections as a function of DCE number within the stim-cycle per AOR

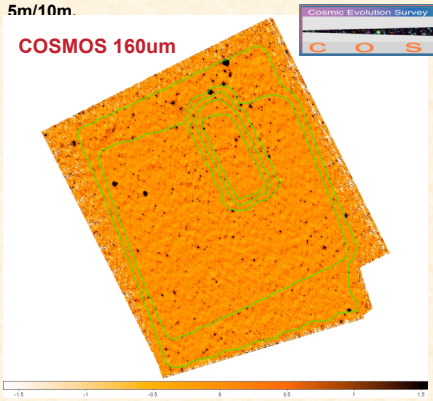
(2) Data co-addition and outlier rejection with MOPEX

## GOODS-N Ultra-Deep 70um Results

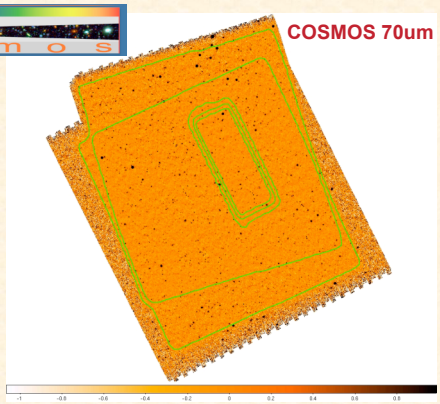



(TOP, Frayer et al. 2006): The differential 70um source counts measured down to 1.2mJy and the confusion measurement of sigma=0.3 mJy (q=5). The Spitzer GO-1 observations covered the central 10'x10' of the GOODS-N field to a depth of 10.6ks. (BOTTOM, Huynh et al. 2007): The infrared luminosity function derived based on the 70um data as a function of redshift. Results consistent with estimates made previously at 24um.

## COSMOS 160um

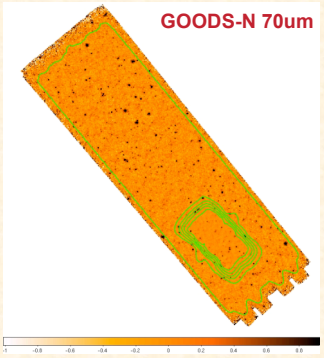


## COSMOS 70um

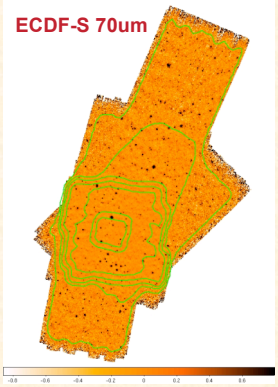


The 160um and 70um observations of the COSMOS field which cover more than 2 sq degree. All data from all cycles and epochs are shown. The green lines show the depth of coverage. For 160um the contours represent integration times of 0.1, 0.2, 0.3, 0.4, and 0.5 ks, while the 70um contours are for 0.5, 1, 1.5, 2, 2.5 ks. The 160um data are confusion limited; confusion noise is sigma ~10 mJy. The central deep field show the "test-field" of Cycle-2, while the area outside the green lines shows the extent of the shallow wide-area survey from Cycle-2. Data were taken over three epochs in Cycle 3, finishing 2008 January.

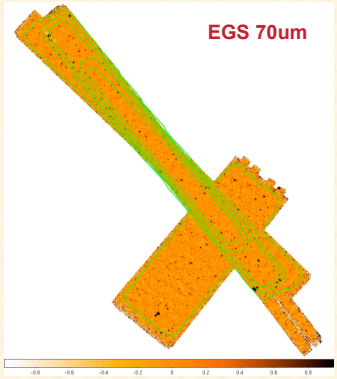
## GOODS-N 70um



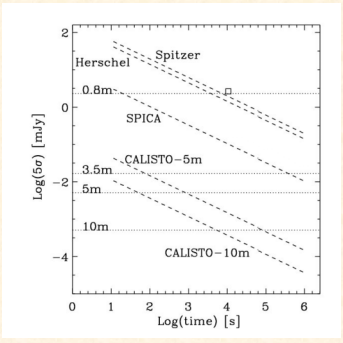
## ECDF-S 70um



## EGS 70um



The combination of all of the 70um data of the GOODS-N (GN), ECDF-S, and EGS fields from the FIDEL, GTO, and GO programs. The contours represent integration times of 0.3, 1, 3, 5, 7, and 9 ks for GN; 0.3, 1, 2, 4, 6, 8, and 10 ks for ECDF-S; and 0.3, 1, 2, 4, and 6 ks for EGS. The deep area for GN represents the FIDEL+Frayer-GO1 observations of the full GN (15'x10'). The 30'x30' ECDF-S field is shown by the square box (3rd contour); the ultra-deep 10'x10' box within ECDF-S shows the Frayer-GO2 observations. The deep observations of EGS cover 90'x10'. Each of the fields also has 160um observations (not shown here). Data deliveries are planned this summer for both COSMOS and FIDEL.




Predicted confusion levels at 70um based on the extrapolation of the GN counts measured with Spitzer (0.8m) for 3.5m (Herschel & SPICA), 5m, and 10m-CALISTO telescopes. The confusion levels shown by the dotted-lines represent 8 beams per source (approximate limit before priors are needed). The 5-sigma telescope sensitivities as a function of integration time are given by the dashed lines. The square is the observed 5-sigma noise for the Spitzer observations (Frayer et al. 2006). The warm Herschel telescope is not expected to reach confusion at 70um, unlike all other bands with Herschel. A 10m cold CALISTO mission could reach 0.5 micro-Jy, which is about 5000 times deeper than the current 70um limits (with the caveat that the extrapolated counts and confusion noise is highly uncertain at these levels).